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# ***CO<sub>2</sub> Capture and Sequestration***

## ***-Overcoming the technical challenges***

***European Commission R & D Policy***

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# Structure of the Presentation

- ✕ Global Policy Context
- ✕ Energy Policy Context
- ✕ Fossil Vs Renewable Energy Sources
- ✕ C+S R&D Policy
- ✕ Current R&D Portfolio
- ✕ International Activities
- ✕ Co-ordination Activities





# Global Policy Context

## Climate change

- ✗ Johannesburg World Summit on Sustainable Development, with Russian announcement that they would ratify Kyoto.
- ✗ EU set to decrease its GHG emission by 8% in 2008-2012 compared to 1990 under the Kyoto Protocol.
- ✗ Burden sharing agreement between Member States.
- ✗ EU on good track so far, but still uncertain whether the -8% will be achieved domestically or through flexible mechanisms.
- ✗ Proposal for an EU Greenhouse Gas Trading Directive and registries.
- ✗ Proposal for a “linking” directive transferring CDM and JI credits into the EU GHG trading directive.
- ✗ European Climate Change Programme to identify most promising and cost-effective routes.
- ✗ CO<sub>2</sub> C+S not yet cost effective in the Kyoto horizon, but promising, hence RTD is needed.



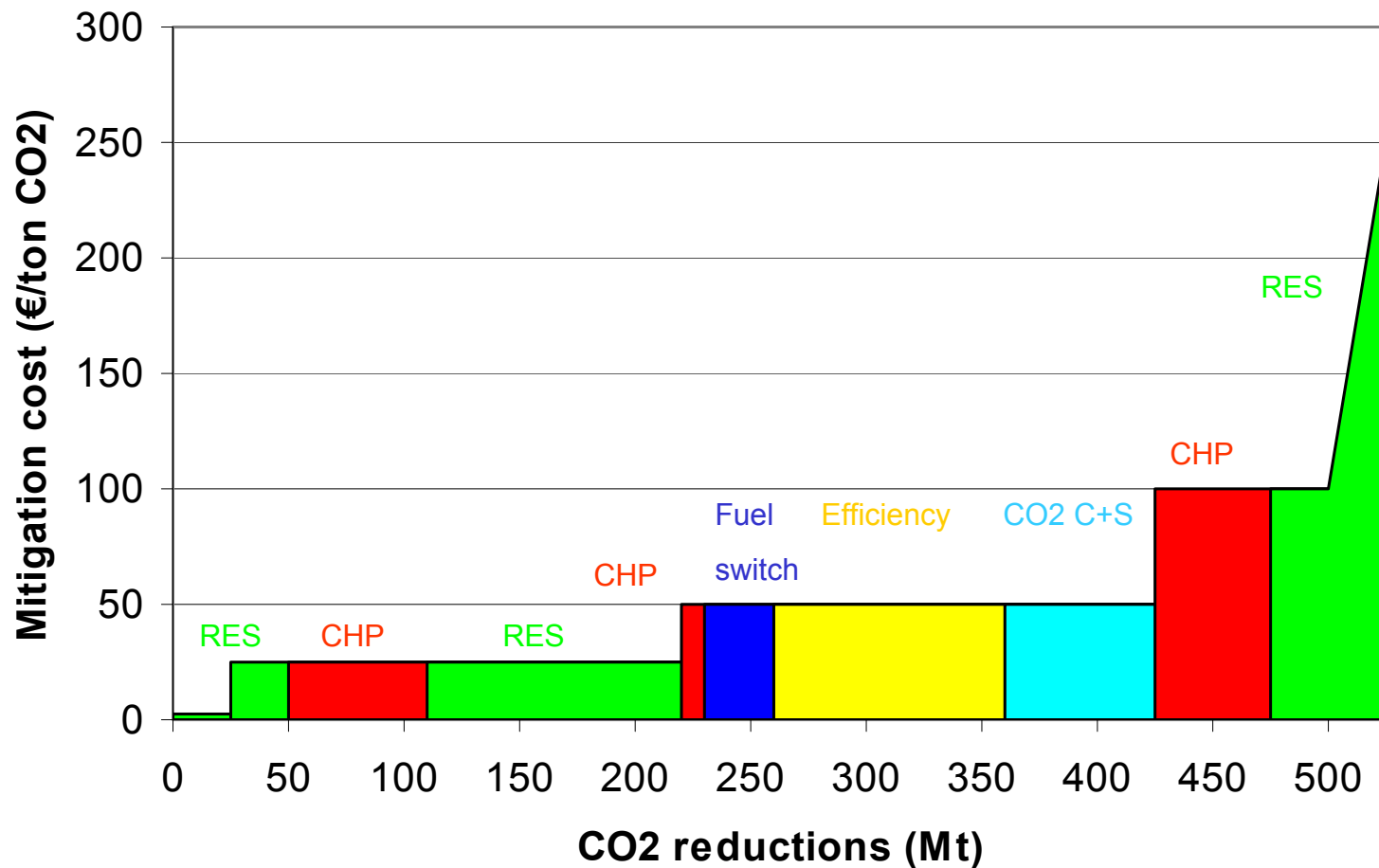


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# Global Policy Context

Cost-effectiveness (ECCP)



Directorate General for Research



# Global Policy Context

## Climate change - Post Kyoto

- ✕ More drastic reductions will be needed
  - ✓ max. 2°C increase, max. 450 ppmv,- 50 / 60% by 2050
  - ✓ from developed economies
  - ✓ also from economies in transition
  
- ✕ In economies in transition, even if the per capita emissions are still low, total emissions will become more and more significant.





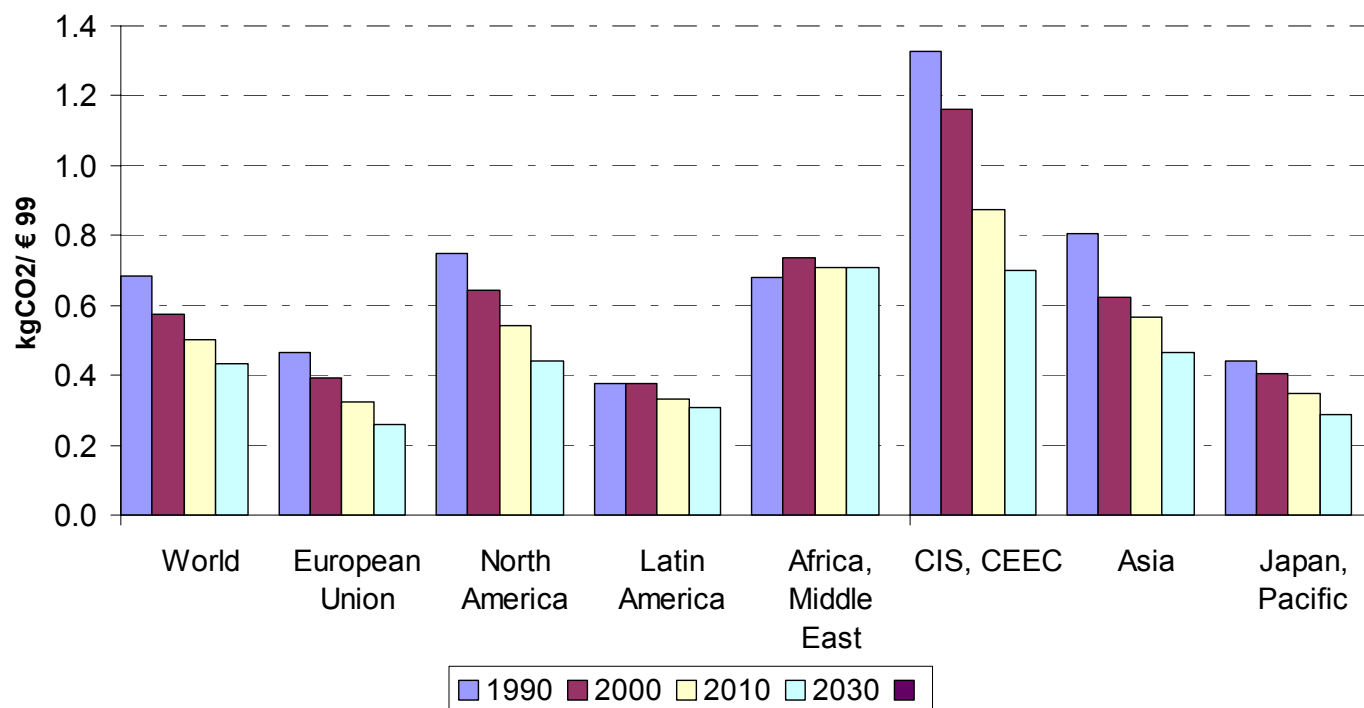
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# Energy Policy Context

## Scenarios and Projections (source : WETO)

### Carbon intensity of GDP





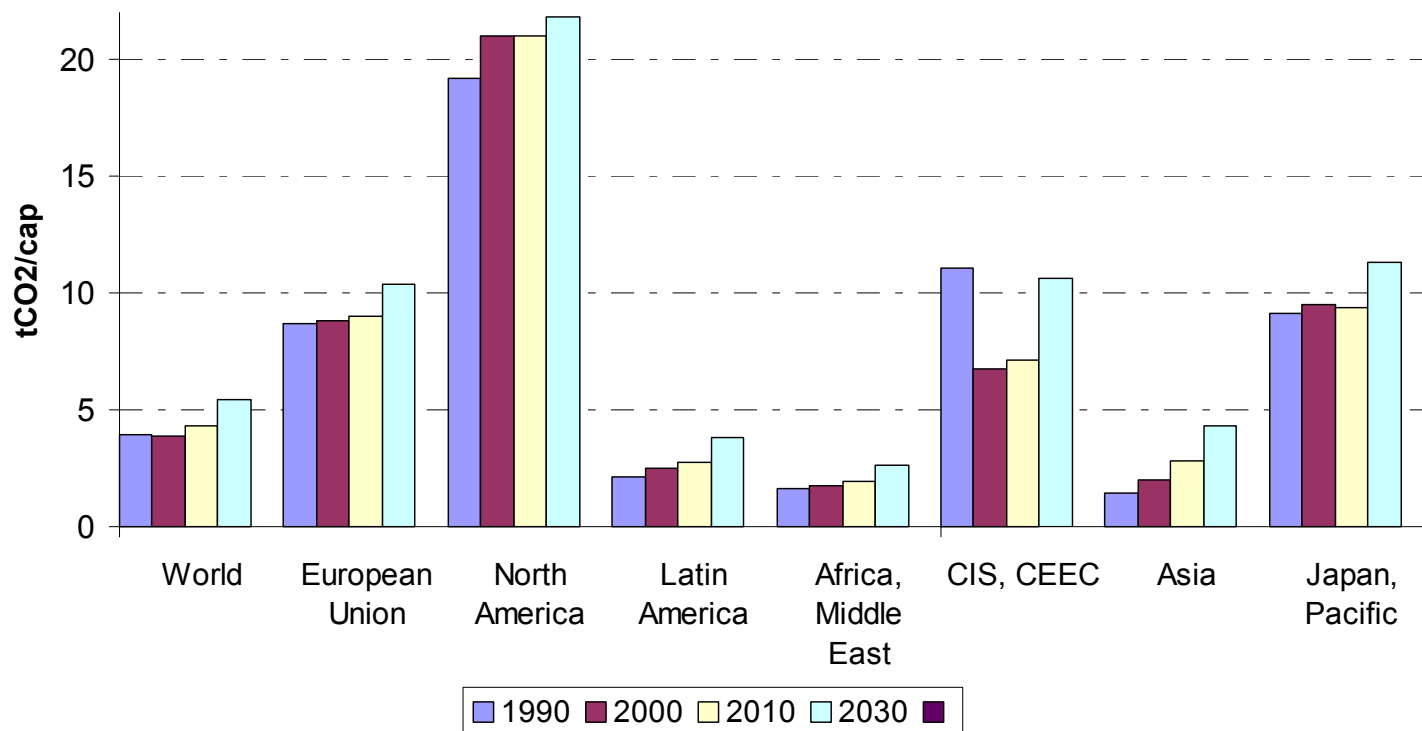
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# Energy Policy Context

## Scenarios and Projections (source : WETO)

CO<sub>2</sub> emissions per capita







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# Energy Policy Context

## Security of Supply (Green Paper)

- ✕ Diversification is the key, no single option is the solution and no option should be ruled out.
- ✕ Need to act on demand and energy efficiency.





# Energy Policy Context

## Industry Competitiveness

- ✕ EU industry must be placed in a position to compete globally in a post-Kyoto scenario.





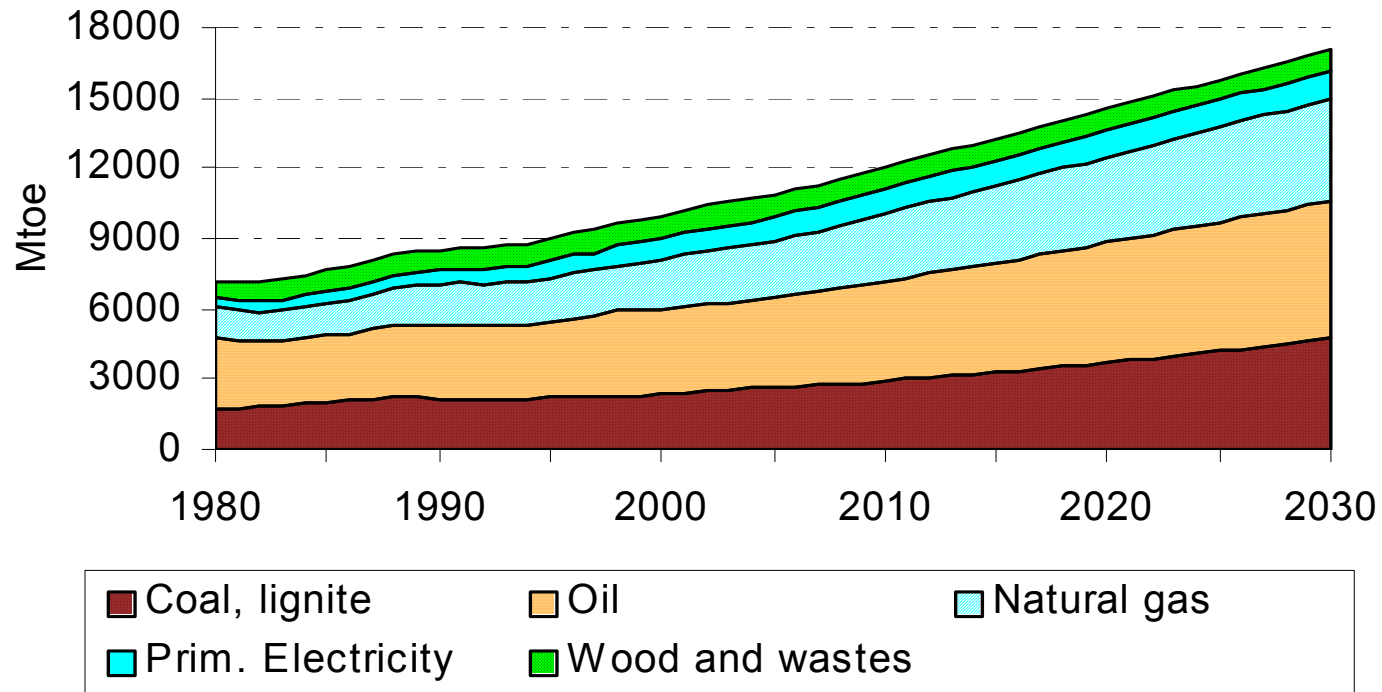
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# Energy Policy Context

## Scenarios and Projections (source : WETO)

Still 90% fossil fuels worldwide by 2030





# Fossil Vs Renewable Energy Sources

- ✗ Some see CO<sub>2</sub> C+S as fossil fuels back by the back-door
- ✗ But projections indicate fossil fuels are here to stay and will be used, especially in economies in transition
- ✗ RES need to be supported, but will not be sufficient in the short to medium term, both in developed and developing economies
- ✗ RES and CO<sub>2</sub> C+S are complementary
  - ✓ from a timing point of view
  - ✓ from a generation mix point of view
  - ✓ to ease the penetration of hydrogen as a vector





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# Fossil Vs Renewable Energy Sources

- ✕ Synergies exist between CO<sub>2</sub> C+S and RES
  - ✓ for example, CO<sub>2</sub> C+S applied to biomass plants
    - leads to negative CO<sub>2</sub> emissions
    - can give CO<sub>2</sub> credits in a tax / trading environment
    - can be applied to fossil fuel / biomass co-utilisation plants





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# CO<sub>2</sub> C+S R&D Policy

A Priority in Long Term Energy R&D in FP6 (2002-2006)

- ✕ *Capture and sequestration of CO<sub>2</sub>, associated with cleaner fossil fuel plants.*
- ✓ *Targets: reduce the cost of CO<sub>2</sub> capture from 50-60 € to 20-30 € per tonne of CO<sub>2</sub> captured, whilst aiming at achieving capture rates above 90%, and assess the reliability and long term stability of sequestration.*





# CO<sub>2</sub> C+S R&D Policy

## A Complementary subject to hydrogen in Long Term Energy R&D in FP6

- ✕ In a transition phase, hydrogen is likely to be mostly produced from fossil fuels.
- ✕ When CO<sub>2</sub> is captured from hydrocarbons, what's left is... hydrogen.





# CO<sub>2</sub> C+S R&D Policy

- ✕ Capture R&D - Objectives

- ✓ 70-80 % of total cost - therefore primary objective is to decrease the cost of capture (to below 20 €/ton).

- ✕ Capture R&D - Ways:

- ✓ pre-combustion capture
- ✓ post-combustion capture
- ✓ oxyfuels







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# CO<sub>2</sub> C+S R&D Policy

## ✕ Sequestration R&D -- Objectives

- ✓ to study long term stability;
  - ✓ to study safety aspects;
  - ✓ to build public confidence to ensure acceptability;
  - ✓ to map geological storage potential.
- 
- ✕ The objective is to move towards a global consideration of capture and sequestration technologies in comprehensive, integrated project(s).





# CO<sub>2</sub> C+S R&D Policy

## ✕ Sequestration R&D - Ways:

- ✓ geological (saline aquifers, depleted oil and gas fields, unminable coal beds, EOR, ECBM);
- ✓ chemical;
- ✓ other innovative ways.
  
- ✓ Other ways
  - oceans - environmentally questioned in Europe;
  - biospheric sinks - doubtful long term value.



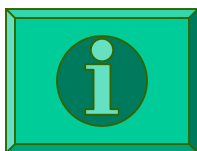


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# Current Project Portfolio

Project	Topic	cost (m€)	funding (m€)	co-ord.	
<u>CAPTURE</u>	AZEP	Advanced membrane cycles	9.3	3.4	Alstom
-	GRACE	Capture in processes	3.2	2.1	BP
<u>SEQUESTRATION</u>	GESTCO	Sequestration Potential	3.8	1.9	GEUS
-	CO2STORE	SACS2 follow-up on land	2.4	1.2	Statoil
-	NASCENT	Natural storage analogues	3.3	1.9	BGS
-	RECOPOL	Enhanced coal bed methane	3.4	1.7	TNO
<u>SEQ. MONITORING</u>	WEYBURN	Weyburn monitoring	2.2	1.2	BGS
-	SACS2	Monitoring Sleipner	2.1	1.2	Statoil
<u>NETWORKING</u>	CO2NET	ERA Dimension - networking	2.1	1.4	Tech.



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# Current Project Portfolio

## × AZEP

- ✓ Research on a new chemical process for the capture of CO<sub>2</sub> from combustion gases in power plant. A highly innovative proposal aimed at reducing the cost of pre-combustion capture of CO<sub>2</sub>. It produces an almost pure stream of liquid CO<sub>2</sub> for storage. It complements existing and proposed European projects in this area.
- ✓ EC Funding 3.4 m€ - Cost 9.3 m€
- ✓ Co-ordinator ALSTOM
- ✓ Started 1 Dec 2001 for 36 months





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# Current Project Portfolio

## × GRACE

- ✓ Research on processes for capture of CO<sub>2</sub> from non-power producing plant (refineries, etc.). Aims at producing a step change in the cost of post-combustion capture of CO<sub>2</sub>. The chemical looping combustion is particularly innovative. The fuel de-carbonization is also innovative when using a membrane. There is also the possibility of generating cheaper Hydrogen.
- ✓ EC Funding: 2.1 m€ - Cost 3.2 m€
- ✓ Co-ordinator BP
- ✓ Started 1 Dec 2001 for 24 months





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# Current Project Portfolio

## × GESTCO

- ✓ A study involving most MS' geological surveys and related organisations to revise an initial JOULE study on sequestration potential in Europe. Initial indications that the potential is even greater than the earlier estimates.
- ✓ EC Funding 1.9 m€ - Cost 3.8 m€
- ✓ Co-ordinator GEUS Danish Geological Survey
- ✓ Started 1 March 2000 for 30 months





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# Current Project Portfolio

## × CO2STORE

- ✓ Investigates four new potential cases for CO<sub>2</sub> reservoirs, mainly on land. It will continue reservoir simulations and study geo-chemical reactions to develop final-fate prediction models. This proposal builds on the SACS2 results by including new seismic observations and introducing gravimetrics as a new method better suited on land.
- ✓ EC Funding: € 1.2 m€ - Cost 2.4 m€
- ✓ Co-ordinator STATOIL
- ✓ Started 1 February 2003 for 36 months





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# Current Project Portfolio

## × NASCENT

- ✓ A study of naturally-occurring CO<sub>2</sub> reservoirs to establish the mechanisms that ensure retention of CO<sub>2</sub> over geological periods of time. Involves US and IEA GHG partners. The results of this project will have a significant input into the feasibility of and public debate on the sequestration of CO<sub>2</sub>.
- ✓ EC Funding €1.9 m€ - Cost 3.3 m€
- ✓ Co-ordinator British Geological Survey
- ✓ Started 1 January 2001 for 36 months







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# Current Project Portfolio

## × RECOPOL

- ✓ A larger scale demonstration project in a Polish coal field. The results of this project will have a significant input into the possibility of using CO<sub>2</sub> storage combined with the production of coal-bed methane and will contribute to the public debate on the sequestration of CO<sub>2</sub>.
- ✓ EC Funding €1.7m€ - Cost 3.4 m€
- ✓ Co-ordinator TNO
- ✓ Started 1 November 2001 for 36 months





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# Current Project Portfolio

## x WEYBURN

- ✓ Support of European teams monitoring the behaviour of CO<sub>2</sub> used for enhanced oil recovery in the mature and well-documented Weyburn oil field in Canada. The CO<sub>2</sub> is transported through a 320km pipeline from North Dakota, so this project involves US and Canadian partners as well.
- ✓ EC Funding €1.2 m€ - Cost 2.2 m€
- ✓ Co-ordinator British Geological Survey
- ✓ Started 1 January 2001 for 42 months





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# Current Project Portfolio

## × SACS2

- ✓ Support of European teams monitoring the behaviour of CO<sub>2</sub> injected in the Sleipner project in the North Sea. This is providing useful data on transport rates, geophysical properties and potential leakage and/or natural sealing mechanisms.
- ✓ EC Funding 1.2 m€ - Cost 2.1 m€
- ✓ Co-ordinator STATOIL
- ✓ Started 1 April 2000 for 24 months



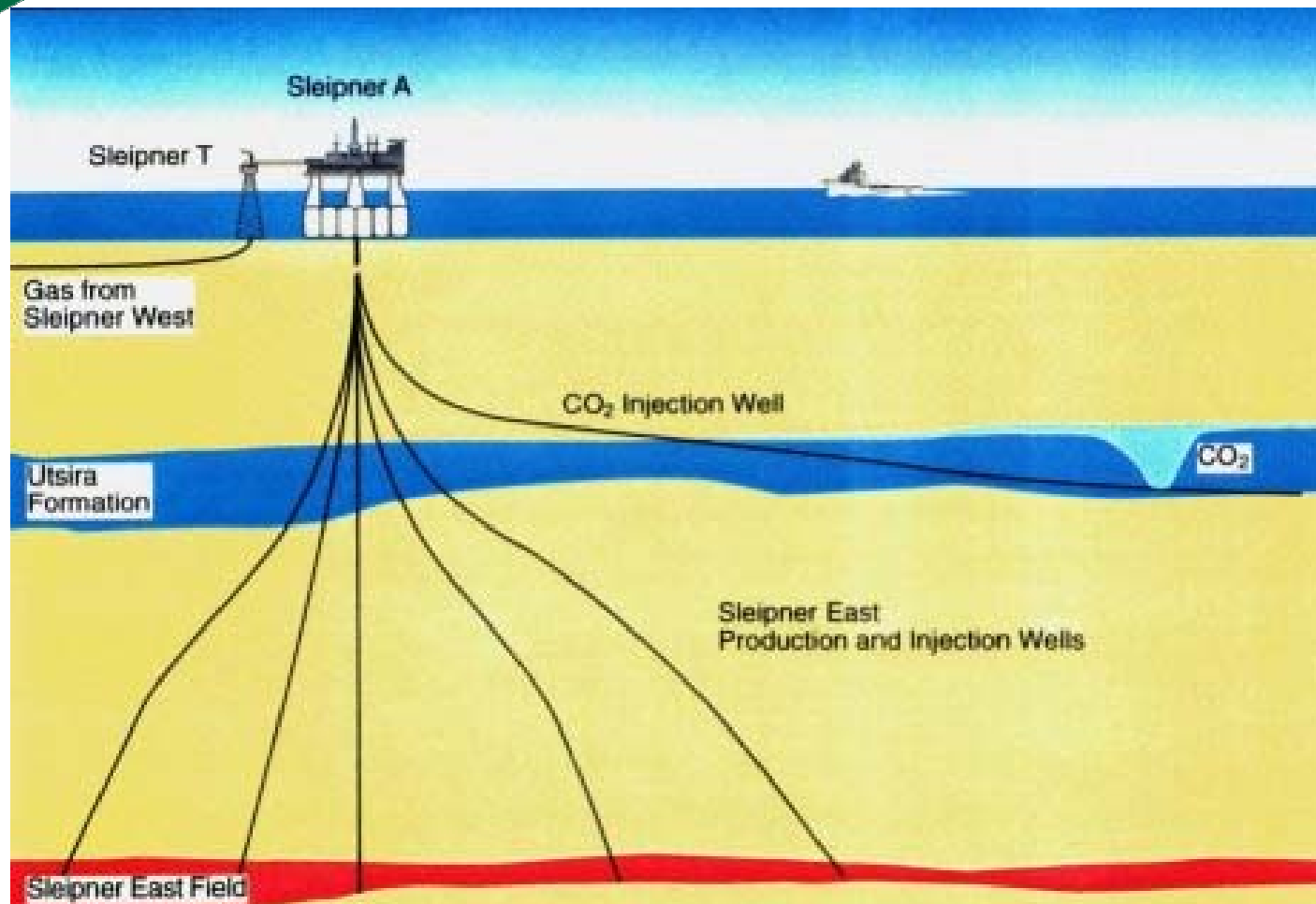


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# Sleipner - CO<sub>2</sub> injection into the Utsira formation -

source : Statoil.





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# Current Project Portfolio

## × CO2NET

- ✓ This CO<sub>2</sub> Thematic Network will facilitate the development of CO<sub>2</sub> capture and storage as a safe, technically feasible, socially acceptable mitigation option.
- ✓ EC Funding : € 1.4 m€ - Cost 2.1 m€
- ✓ Co-ordinator SME Technology Initiatives
- ✓ Started 1 November 2002 for 36 months
- ✓ <http://www.co2net.com/>





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# Current Project Portfolio - What's next ?

- ✕ The first FP6 call was published on 17 Dec 2002
  - ✓ deadline 18 March 2003 - budget 198 m€ for long term energy research, for hydrogen, fuel cells, renewables, and CO<sub>2</sub> C+S.
  - ✓ call asking for 2 IPs and 1 NoE, plus STREPs, CAs, SSAs.
  - ✓ Assessment under way
  - ✓ Negotiations over summer
  - ✓ Contract signatures by end 2003
- ✕ Providing means of international (i.e. non-EU) participation





# International Activities

- ✕ The EC is active in the International Energy Agency of the OECD
  - ✓ In the CERT and the WPFF
    - taking a role in its ZETS strategy
  - ✓ In the IEA Greenhouse Gas implementing agreement
  - ✓ In the IEA Clean Coal Centre implementing agreement
- ✕ S&T agreements with Argentina, Australia, Canada, China, India, Russia, South Africa and the USA.
  - ✓ Implementing Agreement with the US DoE.
- ✕ Future member of the CSLF





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# Co-ordination of Member States Activities

- ✕ As part of its ERA strategy, FP6 provides ways to co-ordinate MS activities :
  - ✓ At the project level, through networking and co-ordination actions
  - ✓ At the programme level, through ERA-NET activities
  - ✓ At the policy / strategy definition level, through the open co-ordination and EU technology platforms

